National Aeronautics and
Space Administration

METRIC/
INCH-POUND

NASA-STD-5008A
January 21, 2004

PROTECTIVE COATING OF CARBON STEEL, STAINLESS STEEL, AND ALUMINUM ON LAUNCH STRUCTURES, FACILITIES, AND GROUND SUPPORT EQUIPMENT

NASA TECHNICAL STANDARD

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DOCUMENT HISTORY LOG, NASA-STD-5008A

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		07/10/2001	Baseline Release
Revision	A	01/21/2004	Foreword: changed signature of W. Brian Keegan to Theron M. Bradley. Updated Table of Contents and KSC FORM 21-61ONS, Standardization Document Improvement Proposal. General editorial/punctuation changes/corrections throughout document: put brackets inside parentheses and deleted “etc.” following “e.g.” Used non, free and proof as combining forms. Put a hyphen between Sherwin Williams. Changed Ameron International, P.C.G. to P.C.F.G. and web site to www.ameron.com. Changed Materials Science Division (LO-G) to Spaceport Technology Development Office (YA-C2). Added paragraph 1.6, Environmental stewardship. Paragraph 2.2: Changed MIL-C-24667A to MIL-PRF-24667A. Deleted MIL-T-81772. Paragraph 2.3: Changed title of ASTM A653 to Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanneeled) by the Hot-Dip Process and changed the ASTM address to 100 Barr Harbor Drive, West Conshohocken, PA 19482-2959. Changed the title of RP0188-88 to Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates. Changed the title of SSPC SP 5-94, Joint Surface Preparation Standard, to SSPC-SP 5-94/NACE No. 1, White Metal Blast Cleaning. Changed SSPC SP 10-94, Joint Surface Preparation Standard Near-White Blast Cleaning, to SSPC-SP 10-00/NACE No. 2, Near-White Blast Cleaning. Paragraph 3: Deleted AISC, American Institute of Steel Construction; cfm, cubic feet per minute; GFE, Government-furnished equipment; and KHB, Kennedy handbook. Changed LO-G to YA-C2-T. Added ASME, American Society of Mechanical Engineers; CFR, Code of Federal Regulations; HAP, hazardous air pollutant; PDCA, Painting and Decorating Contractors of America; and YA-F, Labs and Testbed Division. Changed mega Pascal to megapascal. Paragraph 4.1.2.4.e.2: Changed 235 to 239. Put parentheses around number listing. Paragraph 4.1.4: Changed Materials and Chemical Analysis Laboratory to Spaceport Technology Development Office. Paragraph 4.3.1: Added “and NASA policies” to the end of the last sentence. 4.4.1: Rewrote the first sentence. Added a sentence after the first sentence. 4.4.3.3 Added /environmental to safety/fire in the last sentence.

DOCUMENT HISTORY LOG, NASA-STD-5008A (cont)

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
			4.5.1: Added "An inorganic zinc coating used in a friction-type joint must be approved by the American Institute of Steel Construction (AISC)," after the fifth sentence. Paragraph 5.7.5, end of the third sentence: Added "while considering the accuracy of the measurement instrument." Appendix A, Section I: Changed zip code for Ameron International, P.C.F.G to 92821. Appendix A, Section II: Added Dimetcote D-9HS SB; SB to Cathacoat 304V; Cathacoat 304H SB; and ZincClad IIHS SB to Coating Designations and Type. Added InterZinc 22HS, SB, International Paint, 6001 Antoine Drive, Houston,TX 77091, (713) 682-1711, www.international-pc.com. Appendix B, Section II: Added (SB) to Primer (Type) D-21-9. Added D-9HS (SB) to Primer (Type) and PSX700(SB) to Topcoat (Type). Appendix B, Section III: Added D-9HS (SB) and ZincClad IIHS (SB) to Primer (Type). Added InterZinc 22HS (SB), 181 (SB) (IOT), International Paint, 6001 Antoine Drive, Houston, TX 77091, (713) 682-1711, www.international-pc.com. Changed Topcoat (Type) 7551 P1 (SB) (IOT) to 5555.

FOREWORD

This standard is approved for use by NASA Headquarters and all NASA Centers and is intended to provide a common framework for consistent practices across NASA programs.

This standard was developed to establish uniform engineering practices and methods and to ensure the inclusion of essential criteria in the coating of ground support equipment (GSE) and facilities used by or for NASA. This standard is applicable to GSE and facilities that support space vehicle or payload programs or projects and to critical facilities at all NASA locations worldwide. The John F. Kennedy Space Center Spaceport Engineering and Technology Directorate developed this standard.

This standard establishes practices for the protective coating of GSE and related facilities used by or for NASA programs and projects. This standard is for the design of nonflight hardware used to support the operations of receiving, transportation, handling, assembly, inspection, test, checkout, service, and launch of space vehicles and payloads at NASA launch, landing, or retrieval sites. These criteria and practices may be used for items used at the manufacturing, development, and test sites upstream of the launch, landing, or retrieval sites.

The information provided herein shall be used for the preparation of written, individual coating specifications for specific projects for the prevention of corrosion through the use of protective coatings on facilities, space vehicle launch structures, and ground support equipment in all environments. Due to the changing environmental considerations, new advances in corrosion control technology, and the wide array of possible applications, this document should not be used as a stand-alone specification that meets every contingency.

Requests for information, corrections, or additions to this standard should be directed to the Spaceport Engineering and Technology Directorate, Mail Code YA, Kennedy Space Center, Florida 32899, using the form attached to the back of this standard. Requests for general information concerning standards should be sent to the NASA Technical Standards Program Office, ED41, MSFC, AL 35812 (telephone 205-544-2448). This and other NASA standards may be viewed and downloaded, free of charge from our NASA Standards Home Page: http://standards.nasa.gov.

Original signed by:

Theron M. Bradley
Chief Engineer

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PROTECTIVE COATING OF CARBON STEEL, STAINLESS STEEL, AND ALUMINUM ON LAUNCH STRUCTURES, FACILITIES, AND GROUND SUPPORT EQUIPMENT

1. SCOPE

1.1 Scope. This document establishes requirements for the application of protective coatings to prevent corrosion of exposed carbon steel, stainless steel, and aluminum.

1.2 Purpose. This document provides a design standard for experienced corrosion control engineers for the development of specifications including requirements for materials, equipment, safety, procedures, and quality assurance inspections. Due to the ever changing environmental considerations, new advances in corrosion technology and the wide array of possible applications, this document shall not be used as a stand-alone standard that meets every contingency. Refer to 7.1 for the intended use and surfaces to be coated according to this standard. Refer to Appendices A, B, and C for approved coating materials.

1.3 Applicability. This standard is applicable to facilities, launch structures, ground support equipment (GSE), test facilities, and structures that are intended for use at all NASA locations worldwide.

1.4 Zones of exposure. The following zones of exposure are established to define coating system requirements for surfaces located in specific environments:

a. Zone 1. Surfaces that receive rocket engine exhaust impingement.

b. Zone 2. Surfaces that receive elevated temperatures (above 65 degrees Celsius [above 150 degrees Fahrenheit]) and/or acid deposition from solid rocket booster exhaust with no exhaust impingement.

c. Zone 3a. Surfaces, other than those located in Zones 1 or 2, that receive acid deposition from solid rocket booster exhaust products.

Zone 3b. Surfaces that receive other types of chemical contamination (e.g., cooling towers, diesel exhaust stacks, acidic industrial environments, and water treatment facilities).

d. Zone 4a. Surfaces not located in the launch environment but located in a neutral pH corrosive marine industrial, or other chloride-containing environments.

Zone 4b. Surfaces located in neutral pH exterior environments in any geographical area.

Zone 4c. Surfaces located in indoor nonair-conditioned environments.

e. Zone 5. Continuous indoor air-conditioned environment such as offices or clean rooms. These areas shall have both temperature and humidity controlled more than 90 percent of the time.

f. Zone 6. Underground, intermittent, or continuous immersion in aqueous environments.

g. Zone 7. Surfaces under thermal insulation, such as chilled water, steam, and heated gas lines.

1.5 Method of specifying coating requirements. Specifications referencing this standard shall include the type of surface to be coated, the zone of exposure, surface preparation, defined paint system, coating thicknesses and, when applicable, the finish color required. These requirements should be assembled in a coating schedule for easy reference. The coating specification shall contain the following key elements: scope, applicable documents, submittals, environmental protection, waste management, safety/personnel protection, materials, tools and equipment, environmental conditions, work schedule, surface preparation (including a listing of abrasive-sensitive hardware to be prepared or protected), coating schedule, coating mixing and application, quality control inspection, reporting, and final acceptance. See Appendix D for a recommended outline and coating schedule of a coating specification.

1.6 Environmental stewardship. Environmental, health, and safety impacts of processes and materials should be taken into account when employing protective coating methods and techniques. Alternative, environmentally friendly materials, which do not contain hexavalent chromium, lead, cadmium, or hazardous air pollutants (HAPs), such as methyl ethyl ketone, toluene, and xylene, should be considered when determining the appropriate coating method/technique for each protective coating application. Coatings containing these hazardous materials are involved in a variety of air, water, and soil pollution concerns. Exposure to these materials also has health impacts that include eye and respiratory irritation, headache, dizziness, memory impairment, neurotoxicity and cancer.

2. APPLICABLE DOCUMENTS

2.1 General. The applicable documents cited in this standard are listed in this section for reference only. The specified technical requirements listed in the body of this document must be met whether or not the source document is listed in this section.

2.2 Government documents. The following Government documents form a part of this document to the extent specified herein. Unless otherwise specified, the issuances in effect on date of invitation for bids or requests for proposals shall apply.

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	Occupational Safety and Health Administration (Occupational Safety and Health Standards)
29 CFR 1926	Occupational Safety and Health Administration (Safety and Health Regulations for Construction)

(Copies of the above documents are available from the Superintendent of Documents, U.S. Government Printing Office, North Capitol & H Streets, Washington, DC 20401.)

DEPARTMENT OF DEFENSE (DOD)

MIL-A-22262	Abrasive Blasting Media Ship Hull Blast Cleaning
MIL-P-85891	Plastic Media, for Removal of Organic Coatings

MIL-PRF-24667A	Coating System, Nonskid, for Roll or Spray Application (Metric)

FEDERAL

FED-STD-595	Colors Used in Government Procurement

MILITARY

T.O. 1-1-691	Aircraft Weapons Systems Cleaning and Corrosion Control

(Copies of the above documents are available from Standardization Documents Order Desk, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

KSC-STD-SF-0004	John F. Kennedy Space Center (KSC) – Safety Standard for Ground Piping Systems Color Coding and Identification
KSC-TM-584	John F. Kennedy Space Center (KSC) – Corrosion Control and Treatment Manual

(Unless otherwise indicated, copies of the above documents are available from any NASA Installation library or documentation repository.)

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the Contracting Officer.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issuances in effect on the date of invitation for bids or request for proposals shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanneeled) by the Hot-Dip Process
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM D520	Standard Specification for Zinc Dust Pigment
ASTM D610	Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D714	Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D1654	Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D4228	Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces
ASTM D4752	Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub

(Copies of the above documents are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19482-2959.)

COMPRESSED GAS ASSOCIATION, INC.

G7.1	Commodity Specification for Air, Fourth Edition

(Copies of the above document are available from the Compressed Gas Association, Inc., Crystal Gateway 1, Suite 501, 1235 Jefferson Davis Highway, Arlington, VA 22202).

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

RP0188-88	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
RP0288-88	Inspection of Linings on Steel and Concrete
TM 01-70	Visual Standard for Surfaces of New Steel Airblast Cleaned with Sand Abrasive
TM 01-75	Visual Standard for Surfaces of New Steel Centrifugally Blast Cleaned With Steel Grit and Shot

NACE Publication No. 6H189	A State-of-the-Art Report of Protective Coatings for Carbon Steel and Austenitic Stainless Steel Surfaces Under Thermal Insulation and Cementitious Fireproofing

(Copies of the above documents are available from the National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77218-8340.)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-AB 1-91	Mineral and Slag Abrasives
SSPC-PA 2-96	Measurement of Dry Coating Thickness With Magnetic Gages
SSPC-SP 1-82	Solvent Cleaning
SSPC-SP 2-95	Hand Tool Cleaning
SSPC-SP 3-95	Power Tool Cleaning
SSPC-SP 5-94/NACE No. 1	White Metal Blast Cleaning
SSPC-SP 10-00/NACE No. 2	Near-White Blast Cleaning
SSPC-SP 11-95	Power Tool Cleaning to Bare Metal
SSPC-VIS 1-89	Visual Standard for Abrasive Blast Cleaning Steel
SSPC-VIS 3-95	Visual Standard for Power- and Hand-Tool Cleaned Steel

(Copies of the above documents are available from the Society for Protective Coatings, 4400 Fifth Avenue, Pittsburgh, PA 15213.)

2.4 Order of precedence. Where this document is adopted or imposed by contract on a program or project, the technical requirements of this document take precedence, in the case of conflict, over the technical requirements cited in other referenced documents. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. ABBREVIATIONS AND ACRONYMS USED IN THIS STANDARD

AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CIP	Coating Inspector Program
DFT	dry film thickness
DOD	Department of Defense

EPA	Environmental Protection Agency
FED	Federal
GSE	ground support equipment
HAP	hazardous air pollutant
IOT	Inorganic topcoat
kPa	kilopascal
KSC	John F. Kennedy Space Center
ksi	kip per square inch
MPa	megapascal
NACE	National Association of Corrosion Engineers
NASA	National Aeronautics and Space Administration
NIOSH	National Institute of Occupational Safety and Health
no.	number
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Act
PDCA	Painting and Decorating Contractors of America
PPE	personal protective equipment
psi	pound per square inch
RH	relative humidity
SB	solvent based
SRB	solid rocket booster
SSPC	Society for Protective Coatings
STD	standard
TCLP	Toxicity Characteristic Leaching Procedure
T.O.	technical order
VOC	Volatile Organic Content
WB	water based
YA-C2-T	Materials Sciences Laboratory
YA-F	Labs and Testbed Division

4. REQUIREMENTS

4.1 Materials.

4.1.1 Abrasive blasting aggregate. Blasting aggregates shall be approved materials in accordance with MIL-A-22262 or SSPC-AB1, Type I or II, Class A, or steel grit. Only materials approved in the QPL attached to MIL-A-22262 shall be used. The abrasive grade selected must produce the required surface profile and possess physical properties that are compatible with the requirements of this standard. The steel grit shall be neutral (6.0 to 8.0 pH), rust and oil free, dry, commercial-grade blasting grit with a hardness of 40 to 50 Rockwell C. The size shall be selected to produce the required anchor profile. For paint removal or cleaning of aluminum, stainless steel, and fiberglass, plastic media in accordance with MIL-P-85891 may be used as an alternate.

NOTE: Only aggregates that are free of crystalline silica shall be selected for use at NASA. Exemptions to this policy shall be coordinated with local Occupational Health Office.

NOTE: Blasting aggregate for abrasion-sensitive hardware (such as bellows, gimbal joints, and other thin-walled components) shall be materials that produce no

additional surface profile. Blasting operations shall not produce holes, cause distortion, remove metal, or cause thinning of the substrate.

4.1.2 Protective coatings, thinners, and cleaners. The following paragraphs establish minimum requirements for each generic type of protective coating specified in this document. See 4.4.3.1 for coating intercoat compatibility requirements. All coatings must possess physical properties and handling characteristics that are compatible with the application requirements of this standard, and all coatings must be self-curing. Thinners and cleaners for each coating, except those specified in 4.1.2.6, shall be procured from the manufacturer of the coating.

Procurement awards for coatings to be supplied according to this standard shall be made only for those products that have been tested, evaluated, and approved by the Spaceport Technology Development Office (YA-C2), KSC. The attention of suppliers is called to this requirement, and manufacturers are urged to arrange for testing of their product so that they may be eligible for award of contracts or orders for coatings to be supplied in accordance with this standard. To arrange for the product testing and testing criteria, manufacturers must contact YA-F, NASA, John F. Kennedy Space Center, FL 32899.

4.1.2.1 Inorganic zinc coatings. Inorganic zinc coatings that have been approved are listed in Appendix A. A coating must meet the following minimum requirements to be listed:

a. Self-curing, two package

b. Dry-temperature resistance to 400 degrees Celsius (750 degrees Fahrenheit) for 24 hours

c. Minimum shelf life of 12 months

d. Minimum of 83 percent zinc by weight in the applied dry film

e. Asbestos free, lead free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating)

f. Zinc dust pigment shall be Type II in accordance with ASTM D520

g. Attain a numerical rating of not less than 9 in accordance with ASTM D610 and ASTM D1654 and 9F in accordance with ASTM D714 when applied to composite test panels and exposed at the KSC beach corrosion test site. The coatings will be evaluated for initial acceptance following an exposure period of 18 months. The coatings must continue to provide acceptable protection and performance for a period of 5 years. Application characteristics must be judged acceptable prior to beach testing.

4.1.2.2 Primer and/or intermediate coatings. These coatings are listed in Appendix B.

4.1.2.2.1 Inhibitive polyamide epoxy coatings. Polyamide epoxy coatings shall conform to the following minimum requirements:

a. Polyamide-cured

b. Rust-inhibitive

c. Lead free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating)

d. Suitable as a primer for carbon steel, galvanized steel, and aluminum

e. Suitable as an intermediate coat between an inorganic zinc primer and an aliphatic polyurethane finish coat

f. Meet the compatibility requirements of 4.4.3.1

g. Minimum 40 percent volume solids

4.1.2.2.2 Noninhibitive polyamide epoxy coatings. Polyamide epoxy coatings shall conform to the following minimum requirements:

a. Polyamide-cured

b. Lead free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating)

c. Suitable as an intermediate coat between inorganic zinc primer and an aliphatic polyurethane finish coat

d. Meet the compatibility requirements of 4.4.3.1

e. Minimum 40 percent volume solids

f. Not to be used as a primer on steel

4.1.2.2.3 Water-reducible intermediate coatings. Water-reducible intermediate coatings shall conform to the following minimum requirements:

a. Self-curing, one or two package, water reducible

b. Lead free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating).

c. Suitable as an intermediate coat between inorganic zinc primers and water-reducible topcoats

d. Meet the compatibility requirements of 4.4.3.1

e. Minimum 30 percent volume solids

f. Not to be used as a primer on steel

4.1.2.3 Finish coatings.

4.1.2.3.1 Aliphatic polyurethane coatings. Aliphatic polyurethane coatings shall conform to the following minimum requirements:

a. Catalyst isocyanate cured

b. High-gloss finish (minimum 85 percent gloss at 60-degree angle)

c. Gloss and color retentive upon prolonged exterior exposure

d. Suitable as an exterior finish coat over an inorganic zinc primer with a polyamide epoxy intermediate coat

e. Meet the compatibility requirements of 4.4.3.1

f. Minimum 44 percent volume solids

g. Lead free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating).

4.1.2.3.2 Water-reducible topcoats. Water-reducible topcoats shall conform to the following minimum requirements:

a. Self-curing, one or two package, water reducible

b. Lead free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating).

c. Gloss and color retentive upon prolonged exterior exposure

d. Semi-gloss or high-gloss finish (semi-gloss 60 to 85 percent at 60-degree angle, high gloss minimum 85 percent at 60-degree angle)

e. Meet the compatibility requirements of 4.4.3.1

4.1.2.3.3 Inorganic topcoats. Inorganic topcoats shall conform to the following minimum requirements:

a. Dry-temperature resistance to 400 degrees Celsius (750 degrees Fahrenheit for 24 hours)

b. Suitable as a topcoat for inorganic zinc and galvanized steel in high-temperature environments

c. See Appendix B for approved coating systems

d. Lead-free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating

e. Attain a numerical rating of not less than 9 in accordance with ASTM D610 and ASTM D1654 and 9F in accordance with ASTM D714 when applied to composite test panels and exposed at the KSC beach corrosion test site. The coatings will be evaluated for initial acceptance following an exposure period of 18 months. The coatings must continue to provide acceptable protection and performance for a period of 5 years. Application characteristics must be judged acceptable prior to beach testing.

4.1.2.3.4 Polysiloxane topcoats. Polysiloxane topcoats shall conform to the following minimum requirements.

a. Suitable as a finish coat for exterior exposure

b. High-gloss finish (minimum 85 percent gloss at 65-degree angle)

c. Gloss and color retentive on prolonged outdoor exposure

d. Lead free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating)

e. Ameron PSX700 or equal

f. Attain a numerical rating of not less than 9 in accordance with ASTM D610 and ASTM D1654 and 9F in accordance with ASTM D714 when applied to composite test panels and exposed at the KSC beach corrosion test site. The coatings will be evaluated for initial acceptance following an exposure period of 18 months. The coatings must continue to provide acceptable protection and performance for a period of 5 years. Application characteristics must be judged acceptable prior to beach testing.

4.1.2.4 Epoxy mastic coatings. Epoxy mastic coatings shall conform to the following minimum requirements:

a. Specifically intended for use over mechanically-cleaned steel

b. Minimum 80 percent volume solids

c. Two-component, catalyst cured, aluminum pigmented

d. Lead free, cadmium free, and chromate free (less than 0.01 percent by weight of mixed coating).

e. Examples of epoxy mastic coating that currently meet these requirements include:

(1) Ameron Amerlock 400 AL
(2) Devoe Bar Rust 239
(3) Dupont 25P
(4) PPG DTR
(5) Sherwin-Williams B58
(6) Sigma 7476

4.1.2.5 Coal tar epoxy. Coal tar epoxy coating shall be a two-component, high-build tar epoxy. The coal tar epoxy shall have minimum volume solids of 65 percent and shall produce a one coat thickness of 585 to 710 micrometers (23 to 28 mils) wet coat or 405 to 510 micrometers (16 to 20 mils) per coat dry film thickness (DFT). Examples of coal tar epoxies that currently meet these requirements include the following:

a. Sherwin-Williams Hi-Mil Sher-Tar

b. Made Well 1103

c. Devoe Devtar 247

4.1.2.6 Potable water epoxy. All coatings for potable water immersion service shall be three-coat epoxy systems that are certified by the National Sanitation Foundation (NSF), Standard 61. Some NSF approved products include:

a. Ameron, Inc., Amercoat 395

b. Devoe Coatings Co., Bar Rust 233

c. Sherwin-Williams Co., Potable Water Epoxy

4.1.2.7 Nonskid coating. Approved nonskid coatings shall meet MIL-PRF-24667, Type 1, Composition G, as supplied by American Safety Technologies, Inc., 565 Eagle Rock Avenue, Roseland, NJ 07068, telephone (800) 631-7841, or approved equal (Primer MS-7C, Topcoat MS 400G, Color Topping MS-200).

4.1.3 Sealants/caulking. Sealants shall be self-curing, single-component, polysulfide rubber or polyurethane material only, conforming to ASTM C920, Type S, Grade NS, Class 25, use NT, A, and O. If not top coated, the caulking shall match the color of the joint surface being caulked. If caulking is to be used in a clean-room environment, an approved low off-gassing material shall be selected.

4.1.4 Chip-free clean-room paint. Paint systems for metal substrates in clean-rooms shall pass adhesion, off-gassing, flammability, and hypergolic compatibility testing at the NASA Spaceport Technology Development Office, Kennedy Space Center, Florida. Approved systems are listed in Appendix C.

4.2 Equipment.

4.2.1 Compressed air. The compressed air system shall be capable of delivering a continuous nozzle pressure to achieve the required surface cleanliness and profile, typically 620 kilopascals (kPa) [90 pounds per square inch (psi)] minimum to each blast nozzle in operation. The required air capacity will depend upon the configuration of the abrasive system used. The air system should comply with the instructions and recommendations of the manufacturer of the abrasive blasting system. The compressed air system shall be equipped with oil and moisture separators to ensure only clean, dry air is provided to the service outlet.

4.2.2 Abrasive blasting system. The abrasive blasting system shall comply with Occupational Safety and Health Act (OSHA), American National Standards Institute (ANSI), and National Institute of Occupational Safety and Health (NIOSH) configurations consisting of, but not limited to, a remote-controlled welded pressure pot conforming to American Society of Mechanical Engineers (ASME) Standards, the required length of blast hose, a venturi nozzle, a respiratory air-line filter, and a blast hood approved by the Mine Safety and Health Administration/NIOSH with the required length of air hose. The blasting system shall be designed to produce the specified cleanliness and profile when coupled with the available compressed air supply.

4.2.3 Coating application system. The coating application equipment shall be an airless spray system, conventional spray system, or other approved equipment in accordance with the coating manufacturer's recommendations and 4.4.3.6.

4.2.4 Breathing air. Compressed breathing air supplied to respiratory protection devices shall meet the requirements of the specification for Grade D breathing air as described in Compressed Gas Association, Inc., specification G7. Compressors for breathing air shall be constructed and located so as to avoid entry of contaminated air into the air supply system. Oil-lubricated compressors shall be equipped with a suitable in-line air filtration system that includes a carbon monoxide sensor and alarm and air-purifying sorbent beds and filters that remove water, dust particles, odors, oil, and other hydrocarbons. Oil-free breathing air compressors do not require carbon monoxide monitoring or air filtration systems. Occupational Health will be notified of all compressors brought on the job site for breathing air supply to coordinate breathing air system inspection. Breathing air couplings shall not be compatible with outlets for nonrespirable shop air or other gas systems to prevent inadvertent servicing of air-line respirators with nonrespirable gases or oxygen. The maximum air-line length for any approved supplied air respirator shall not exceed 100 meters (330 feet) measured from the pressure reducing valve. Air lines shall be protected from damage, including cutting, kinking, crushing, or burning. Notification will include written certification that the breathing air supplied by the compressors has been tested and the air meets the specification for grade D breathing air.

4.3 Safety requirements. Necessary precautions, in accordance with OSHA regulations and manufacturers' recommendations, shall be taken to ensure the safety of personnel performing the work required by this document and personnel who may be affected by such work. Some of the materials handled in accordance with this document are combustible, or toxic, or both. The Contractor shall be responsible for providing equipment as required for safe application and for instructing the users regarding the hazards and proper handling and disposal procedures to prevent damage to health. The Contractor shall provide safe access to all areas for the coating inspector. The Contractor shall submit a written safety plan that includes a Hazard Communication Program, a Respiratory Protection Program, and a Hearing Conservation Program that conforms to OSHA requirements. Where the Contractor is required to perform removal of surface coatings that contain lead, chromium, mercury, or cadmium, the safety plan shall also include specific provisions for OSHA compliance for work with these materials and include a hazardous coating removal program in compliance with 4.3.3.

4.3.1 Environmental requirements. The operations described in this standard have the potential to pollute the environment. All local, state, and Federal environmental regulations, as well as the installation environmental policies, shall be followed. Questions regarding these regulations and policies should be directed to the local environmental management organization. Material waste shall be handled and disposed in accordance with the local environmental regulations and NASA policies.

4.3.2 Personal protective equipment (PPE). When engineering controls are not available to protect workers, then PPE and/or administrative controls shall be used. Where required, PPE shall be provided, used, and maintained in a reliable and sanitary condition. Both the supervisors and the workers shall be properly instructed, trained, and certified in the selection, use, and maintenance of PPE.

4.3.3 Hazardous coating removal program. Each contractor shall have a hazardous coating removal program to document and control coating removal and application operations in strict compliance with OSHA 29CFR Part 1910.1025, 1926.62, and 1926.63. This program shall also include applicable requirements from Environmental Protection Agency (EPA) environmental protection issues and hazardous waste disposal.

4.4 General requirements.

4.4.1 Applicator qualifications. To ensure the highest quality of workmanship, only coating applicators who have worked in the printing trade sufficiently long enough to master the use of all applicable tools and materials shall be assigned to perform the work described herein. The applicator's proficiency and ability to attain the required quality of workmanship for the specified coating system can be verified by testing and qualification in accordance with ASTM D4228. In addition, the coating applicators shall provide written evidence of having successfully completed a comprehensive training program such as Painting and Decorating Contractors of America (PDCA)/NACE/SSPC Industrial Painters Training, or equal. The Contractor shall be responsible for providing all painting personnel an orientation on the proper mixing and application of the coatings specified, particularly inorganic zinc coatings. Topics in the orientation shall include specification requirements, material application characteristics, and inspection criteria. Only personnel receiving training may mix or apply coatings. The Contractor shall prepare representative sample areas which meet specification requirements.

4.4.2 Preparation of surfaces. All surfaces to be coated shall be clean, dry, and free from oil, grease, dirt, dust, corrosion, peeling paint, caulking, weld spatter, and any other surface contaminants. All surfaces that will become inaccessible after fabrication, erection, or installation shall be prepared and coated while accessible. Surface preparation and coating operations shall be sequenced so that freshly applied coatings will not be contaminated by dust or foreign matter. All equipment and adjacent surfaces not to be coated shall be protected from surface preparation operations. Working mechanisms shall be protected against intrusion of abrasive. All surfaces shall be degreased, as required, prior to subsequent surface preparation procedures or the application of protective coatings, or both. The following surface preparation techniques shall be used when specified in 4.5.

4.4.2.1 Cleaning and degreasing. Degreasing shall be by solvent cleaning, detergent washing, or steam cleaning in accordance with SSPC-SP 1. This procedure shall be followed when cleaning steel, galvanized steel, or stainless steel. NASA policy prohibits the use of chlorofluorocarbon solvents. Selection of solvents shall be in accordance with all applicable Federal, state, and NASA environmental policies. Water washing shall be done when high levels of chloride or other undesirable contaminants are found on the surfaces and shall be accomplished using standard industrial pressure cleaners with a pressure versus volume output balance that will ensure thorough and productive cleaning. High-pressure water cleaning shall not be used as a cleaning method if existing paint film on a surface exceeds any Toxicity Characteristic Leaching Procedure (TCLP) listed toxic characteristics. No chemical shall be added to the water used for the paint blasting/removal operation, and no discharge shall be directed to surface waters. A 40-micrometer filter mesh shall be utilized to screen wastewater discharge on operations performed over pervious surfaces. Points of discharge shall be identified prior to water blasting operations performed over impervious surfaces. All discharges shall then be channeled to pervious areas with a combination of sandbags and a 40-micrometer filter mesh. Any residues generated in water blasting operations shall be disposed of in accordance with the local environmental regulations. All records of water blasting operations shall be submitted to the local environmental management office. The cleaned surface shall be

free of loose coatings, chlorides, dirt, dust, mildew, grinding/welding/cutting debris, and visible contaminants. The surface shall be clean and dry prior to the abrasive blasting operations and application of coatings.

4.4.2.2 Abrasive blasting. The abrasive blasting aggregate shall be clean and dry and shall conform to 4.1.1. The abrasive blasting system shall conform to 4.2.2. Abrasive blasting shall be in accordance with the applicable paragraphs in 4.5. Abrasive residues shall be removed from the surface, leaving it clean and dry prior to the application of coatings. All abrasive blasting operations shall be contained for particulate emissions during work. The containment system shall be designed to comply with all applicable Federal, state, and local regulations as well as all NASA policies. Exemptions to this requirement shall be coordinated with the local environmental management office.

Care shall be taken in the identification and selection of aggregate for preparation of abrasive-sensitive hardware such as bellows, gimbal joints, and other thin-walled components.

4.4.2.3 Mechanical cleaning methods. Mechanical methods shall be in accordance with the applicable paragraph in 4.5.

4.4.3 Application of coatings. All prepared surfaces shall be coated within 6 hours after completion of surface preparation and before corrosion or recontamination occurs. Surfaces prepared under temperature and humidity control may be coated after 6 hours but only after surface preparation reinspection confirms the specified cleanliness. Any surface that shows corrosion or contamination, regardless of the length of time after preparation, shall be re-prepared. The application and handling characteristics of all coatings will vary. To obtain optimum performance, adequate written instructions from the manufacturer are essential and must be closely followed in conjunction with the requirements defined herein. The manufacturer's written recommendations for thinning, mixing, handling, and applying the product shall be strictly followed. All coatings shall be thoroughly worked into all joints, crevices, and open spaces. All newly coated surfaces shall be protected from damage. All equipment and adjacent surfaces not to be coated shall be protected from overspray and splattered coatings. All spray painting operations shall be contained for particulate emissions during work. The containment system shall be designed to comply with all Federal, state, and local regulations as well as all NASA policies. Exemptions to this requirement shall be coordinated with the local environmental management organization.

4.4.3.1 Coating systems. Coating systems for specified uses and substrates shall be as defined in 4.5 and shall conform to 4.1.2. All thinners and cleaners shall be products of the coating manufacturer except as defined in 4.1.2.7. To ensure intercoat compatibility, coating systems consisting of more than one coat shall be products of the same manufacturer, except for inorganic and polysiloxane topcoats as referenced in 4.1.2.3.3 and 4.1.2.3.4. Continuity of the coating manufacturer's system shall be maintained for the duration of an individual project.

4.4.3.2 Colors. Inorganic zinc coatings shall be pigmented so that there is a definite contrast between the coating and the dull gray appearance of the blasted steel surface during the coating application. Color coding for fluid system piping shall be in accordance with KSC-STD-SF-0004. Finish coat colors shall be in accordance with the following FED-STD-595 color numbers using pigments free of lead, chromium, and cadmium:

a. White, no. 17925

b. Blue, no. 15102 (safety)

c. Yellow, no. 13538 (standard)

d. Yellow, no. 13655 (safety)

e. Red, no. 11136

f. Red, no. 11105 (safety)

g. Black, no. 17038

h. Green, no. 14110 (safety)

i. Gray, no. 16187 (safety)

j. Brown, no. 10080 (safety)

k. Gray, no. 16473 (standard)

4.4.3.3 Storage of coating materials. Coating materials and thinners shall be stored in their original containers bearing the manufacturer's name, product identification, shelf life, and batch number. Coatings, thinners, and cleaners shall be stored in tightly closed containers in a covered, well-ventilated area where they will not be exposed to sparks, flame, direct sunlight, high heat, or rainfall. The manufacturer's written instructions for storage limitations shall be followed. Tarpaulins shall not be utilized as a sole means of covering coating materials for storage. If Material Safety Data Sheets are included with coating materials or thinners, they must be maintained in the area. The Contractor shall submit a written plan for approval for storage of coating materials for coordination with the local safety/fire/environmental organization.

4.4.3.4 Mixing and application instructions. Coating materials shall be thoroughly mixed prior to application with a mechanical mixing instrument that will not induce air into the coating, such as a Jiffy Mixer, manufactured by the Jiffy Mixer Company, Inc., San Francisco, CA, or approved equal. The mixer shall be powered by an air motor or an explosionproof electric motor. All mixing operations shall be performed over an impervious surface with provisions to prevent runoff to grade of any spilled material. The mixed coating material shall be strained through a 30- to 60-mesh screen prior to application. Thinning shall be for viscosity control only. The manufacturer's recommended thinner and amount shall be used except as defined in 4.1.2.7. The material shall be agitated as required during application to maintain uniform suspension of solids. Continuous rapid agitation shall be avoided. Spray equipment shall be adjusted to produce an even, wet coat with minimum overspray. The conventional pressure pot, when used, shall be kept at approximately the same level or above the spray gun for proper material delivery. Coatings shall be applied in even, parallel passes, overlapping 50 percent.

4.4.3.5 Weather conditions. No coating shall be applied when contamination from rainfall is imminent or when the temperature or humidity is outside limits recommended by the coating manufacturer. To prevent moisture condensation during application, surface temperature must be at least 3 degrees Celsius (5 degrees Fahrenheit) above the dewpoint. Wind speed shall not exceed 25 kilometers per hour (15 miles per hour) in the immediate coating area when using spray application methods.

NOTE: Relative humidity (RH) limitations using certain coatings shall be followed:

a. <40% RH solvent-based inorganic zinc coatings, PSX 700, and inorganic topcoats shall not be applied.

b. <40% or >80% RH water-based inorganic zinc coatings shall not be applied.

4.4.3.6 Methods of application. Coatings shall be applied with airless or conventional spray equipment, or both, according to 4.2.3. Application with brushes shall be permitted for minor touchup of spray applications and stripe coats of inorganic zinc. Organic midcoats and topcoats may be applied using brush, roller, or spray as applicable.

4.4.3.7 Coating finish. Each coat of material applied shall be free of runs, sags, blisters, bubbles, and mudcracking; variations in color, gloss, and texture; holidays (missed areas); excessive film buildup; foreign contaminants; dry overspray; etc. Special care shall be taken to ensure complete coverage and proper thickness on welds, corners, crevices, sharp edges, bolts, nuts, and rivets. Each coat of applied material shall be rendered clean, dry, and free from surface contaminants prior to the application of the next successive coating.

4.4.3.8 Touchup of welds and damaged coatings. Field welds and damaged coatings shall be touched up in accordance with 4.5.7. The coating shall be applied in accordance with 4.4.3.4 and 4.4.3.6. Touchup and repair shall be accomplished promptly after the damage or welding has occurred.

4.4.3.9 Coating, drying, and curing. The coating manufacturer's recommended drying and curing times for handling, recoating, and topcoating shall be followed. Coating manufacturer’s recommendations shall be followed to test coating for proper curing. Proper curing of solvent-based inorganic zinc-rich coatings must be verified by ASTM D4752 prior to further coating. Water-based inorganic zinc-rich coatings must be verified for curing, in accordance with the same procedure, but water must be substituted as the solvent.

NOTE: The cure of solvent-based inorganic zinc coatings can be accelerated by rinsing or spraying with fresh water after an initial overnight drying. Number and frequency of rinse cycles can vary with environmental conditions. Check with material manufacturer for recommended procedures.

4.4.4 Sealing/caulking. The perimeter of all faying surfaces, joints open less than 13 millimeters (1/2 inch), and skip-welded joints shall be completely sealed. The sealant shall be a self-curing, single-component, polysulfide rubber or polyurethane type, conforming to 4.1.3. The sealant shall be applied to the joint with a caulking gun following the application of the inorganic zinc primer on carbon steel. For topcoated zinc primers, apply caulking after epoxy intermediate coat, and for coatings on stainless steel, galvanized steel, and aluminum, apply caulking before application of the topcoat. The bead shall have a smooth and uniform finish and shall be cured (tacky to touch) prior to topcoat application.

4.5 Specific requirements.

4.5.1 Protection of carbon steel. Carbon steel surfaces shall be protected from atmospheric corrosion through the application of zinc coatings (inorganic zinc coating and/or hot-dip galvanizing and/or metallizing) as defined herein. New steel components, such as stair

treads, grating, handrails, pipes, and hardware (nuts, bolts, and fasteners), shall be hot-dip galvanized in accordance with 4.5.1.2.1, as applicable. All other carbon steel surfaces that are exposed to the atmosphere shall be coated with inorganic zinc conforming to 4.1.2 in accordance with 4.4.3, hot-dip galvanized (zinc coated) in accordance with 4.5.1.2.1, or metallized in accordance with 4.5.1.3. The zinc coatings may require topcoating with additional protective coatings as specified, but in neutral pH atmospheres, testing has proven untopcoated zinc to have superior performance. Carbon steel faying surfaces that are a part of all friction-type and electrical grounding joints shall be abrasive blasted and coated with 100 to 150 micrometers (4 to 6 mils) of inorganic zinc only, in accordance with 4.5.1.1.4, prior to installation. An inorganic zinc coating used in a friction-type joint must be approved by the American Institute of Steel Construction (AISC). The recommended coating application sequence for carbon steel shall be to abrasive blast and prime with inorganic zinc prior to installation or erection. Further topcoating, if required, shall be accomplished after all welding, grinding, or drilling has been completed, and areas damaged by these procedures have been properly repaired with inorganic zinc.

4.5.1.1 Protection with inorganic zinc.

4.5.1.1.1 Mechanical cleaning of carbon steel. After cleaning and degreasing in accordance with SSPC-SP 1, mechanical cleaning of carbon steel shall be used only as a preabrasive blasting preparation method. Carbon steel shall be mechanically cleaned using needle scalers and/or abrasive discs or wheels in accordance with SSPC-SP 2 or SSPC-SP 3. All weld slag, weld spatter, and foreign matter shall be removed from welds prior to abrasive blasting.

4.5.1.1.2 Abrasive blasting of carbon steel. Carbon steel shall be abrasive blasted to near-white metal (NACE no. 2 in accordance with NACE STD TM 01-70, NACE STD TM 01-75, or SSPC-SP 10) with aggregate conforming to the requirements in 4.1.1. The anchor profile of the blasted surface shall be 40 to 75 micrometers (1.5 to 3.0 mils). All rust shall be completely removed from pits and depressions.

4.5.1.1.3 Stripe coat application. Brush coating and/or stripe coating with a primer shall be applied to welds, cutouts, sharp edges, rivets, crevices, and bolts to ensure complete coverage and proper thickness prior to final primer applications.

4.5.1.1.4 Application of inorganic zinc coatings. Inorganic zinc coatings shall be applied to a DFT of 100 micrometers (4.0 mils) minimum to 150 micrometers (6.0 mils) maximum when they will be left untopcoated or when inorganic topcoat or ablative coating is applied. When the zinc coatings are to be topcoated with organic topcoats, the DFT shall be reduced to 65 micrometers (2.5 mils) minimum to 100 micrometers (4.0 mils) maximum. The proper DFT for the inorganic zinc coating shall be obtained in a single application, which may consist of multiple passes, while coating is still wet.

4.5.1.1.5 Topcoat systems for zinc coatings. The following topcoat systems shall be applied over the zinc coatings as required for each zone of exposure described in 1.1. Topcoats shall be applied at the DFT recommended by the manufacturer or as specified below. The film thickness of the topcoats shall be sufficient to ensure uniform coverage and color.

a. Zone 1. Zinc coatings shall be left untopcoated. As an alternate, surfaces may be topcoated with a heat-resistant coating material such as a silicone ablative.

b. Zone 2. An inorganic topcoat conforming to 4.1.2.3.3 shall be applied at a DFT of 75 to 125 micrometers (3 to 5 mils). As an alternate, surfaces may be topcoated with a heat-resistant coating material such as a silicone ablative.

c. Zones 3a and 3b. An intermediate/tie coat and a finish coat conforming to 4.1.2 shall be applied in accordance with 4.4.3. As an alternate, an inorganic topcoat conforming to 4.1.2.3.3 or a polysiloxane finish coat conforming to 4.1.2.3.4 shall be applied at a DFT of 75 to 125 micrometers (3 to 5 mils).

d. Zones 4a, 4b, and 4c. No topcoats are required, except for color coding, safety, identification, or special conditions. When required, topcoats shall be in accordance with 4.5.1.1.5.c.

e. Zone 5. Zinc coating is suggested but not required. As an alternate, use inhibitive epoxy primer and a polyurethane finish coat conforming to 4.1.2 at the manufacturer's recommended thickness.

f. Zone 6. The coating system shall be as specified in 4.5.4 and 4.5.5.

g. Zone 7. The coating system shall be as specified in NACE Publication No. 6H189.

4.5.1.2 Protection by galvanizing.

4.5.1.2.1 Galvanizing. Galvanizing (zinc coating) shall be accomplished after fabrication by the hot-dip process conforming to ASTM A123, ASTM A153, and ASTM A653. Galvanizing weight for steel sheet without further coating protection shall be ASTM A653, G165. All lower galvanizing weights for steel sheet must be further protected with coatings except for Zone 5 exposures.

NOTE: High-strength steels are susceptible to embrittlement by hydrogen during the galvanizing process. Steel components with an ultimate tensile strength above 900 megapascals (MPa) (130 kips per square inch [ksi]) or hardness above Rockwell C Hardness 28 shall not be galvanized.

4.5.1.2.2 Surface preparation of galvanizing.

CAUTION: Some galvanized configurations are susceptible to distortion when they are abrasive blasted. Special care shall be taken to ensure against any metal distortion by reducing blast nozzle pressure and increasing the working distance from nozzle to surface. In some cases, such as in the surface preparation of light-gage sheet, these precautions may not be sufficient to prevent distortion; and alternate procedures, such as abrading or mechanical cleaning, must be used to remove corrosion or roughen the surface. Galvanized surfaces shall be abrasive blasted with fine abrasives conforming to the requirements in 4.1.1 to remove corrosion and old coatings or roughen new surfaces. The blasted surface shall be free of all corrosion and foreign matter and have a uniform, slightly roughened appearance.

Galvanized surfaces to be further topcoated shall be prepared by degreasing in accordance with 4.4.2.1 prior to any additional surface preparation. After degreasing, abrasive blasting or

mechanical cleaning shall be performed as required by the zone of exposure. If galvanized steel is prepared for the application of coatings by abrasive blasting, it shall be lightly brush blasted with fine abrasive at a lower pressure of 275 to 420 kPa (40 to 60 psi) to provide a corrosionfree and uniform, slightly roughened surface. Care shall be taken not to completely remove the galvanized finish. The zinc coatings shall be maintained or rendered clean, dry, and free from contaminants prior to the application of topcoat systems. Field repair of damaged galvanizing shall be accomplished in accordance with ASTM A780 using inorganic zinc coatings.

Galvanized steel that is to be mechanically cleaned shall be cleaned in accordance with SSPC-SP 3 using abrasive discs/sheets, or other approved methods. All corrosion and foreign matter shall be completely removed and the entire surface slightly roughened.

4.5.1.2.3 Coating systems for galvanizing.

a. Zone 1. Galvanizing may be left untopcoated. As an alternate, surfaces may be topcoated with a heat-resistant coating material such as a silicone ablative.

b. Zone 2. After brush blasting, an inorganic topcoat conforming to 4.1.2.3.3 shall be applied at a DFT of 75 to 125 micrometers (3 to 5 mils). As an alternate, surfaces may be topcoated with a heat-resistant coating material such as a silicone ablative.

c. Zones 3a and 3b. After brush blasting, primer/tiecoat and finish coat conforming to 4.1.2 shall be applied in accordance with manufacturer's recommended thicknesses. As an alternate, inorganic topcoat conforming to 4.1.2.3.3 or a polysiloxane finish coat conforming to 4.1.2.3.4 shall be applied at a DFT of 75 to 125 micrometers (3 to 5 mils).

d. Zones 4a, 4b, and 4c. No topcoats are required for galvanizing weights meeting or exceeding ASTM A123, A153, and A653 G165. When steel sheet is galvanized less than ASTM A653 G165, further coating in accordance with Zone 3 is required. As an alternate to topcoats, steel sheet shall be degreased, brush blasted, and an inorganic zinc primer conforming to 4.1.2.1 applied to a DFT of 50 to 75 micrometers (2 to 3 mils).

e. Zone 5. No topcoats are required, except for color coding, safety, identification, or special conditions. When topcoats are required, the surface shall be degreased and an epoxy primer applied to a DFT of 40 to 75 micrometers (1.5 to 3.0 mils). Within 8 hours, a polyurethane finish coat conforming to 4.1.2 shall be applied to a DFT of 40 to 75 micrometers (1.5 to 3 mils). As an alternate, polysiloxane topcoat conforming to 4.1.2.3.4 shall be applied to a DFT of 75 to 125 micrometers (3 to 5 mils).

f. Zone 6. Coating system shall be as specified in 4.5.4 and 4.5.5.

g. Zone 7. The coating system shall be as specified in NACE Publication No. 6H189.

4.5.1.3 Protection with metallizing.

4.5.1.3.1 Mechanical cleaning of carbon steel. After cleaning and degreasing in accordance with SSPC-SP 1, mechanical cleaning of carbon steel shall be used only as a preabrasive blasting preparation method. Carbon steel shall be mechanically cleaned using needle scalers and/or abrasive discs or wheels in accordance with SSPC-SP 2 or SSPC-SP 3. All weld slag, weld spatter, and foreign matter shall be removed from welds prior to abrasive blasting.

4.5.1.3.2 Abrasive blasting of carbon steel. Carbon steel shall be abrasive blasted to near-white metal (NACE no. 2 in accordance with NACE STD TM-01-70, NACE STD TM 01-75, or SSPC-SP 10) with aggregate conforming to the requirements in 3.1.1. The anchor profile of the blasted surface shall be 40 to 75 micrometers (1.5 to 3 mils). All rust shall be completely removed from pits and depressions.

4.5.1.3.3 Stripe coat application. Stripe coating with metallizing shall be applied to welds, cutouts, sharp edges, rivets, crevices, and bolts to ensure complete coverage and proper thickness prior to final coating applications.

4.5.1.3.4 Application of metallized zinc coatings. Metal wire to be used with the arc spray metallizing equipment shall be pure zinc, 90-10 zinc-aluminum, or 85-15 zinc-aluminum alloys. Metallized zinc coatings shall be applied to a DFT of 100 micrometers (4 mils) minimum to 250 micrometers (10 mils) maximum when they will be left untopcoated or when inorganic topcoat or ablative coating is applied. When the metallized zinc coatings are to be topcoated with organic topcoats, the DFT shall be 100 micrometers (4 mils) minimum to 150 micrometers (6 mils) maximum.

4.5.1.3.5 Topcoat systems for metallized zinc coatings. The following topcoat systems shall be applied over the metallized zinc coatings as required for each zone of exposure described in 1.1. Topcoats shall be applied at the DFT recommended by the manufacturer or as specified below. The film thickness of the topcoats shall be sufficient to ensure uniform coverage and color.

a. Zone 1. Metallized zinc coatings shall be left untopcoated. As an alternate, surfaces may be topcoated with a heat-resistant coating material such as a silicone ablative.

b. Zone 2. An inorganic topcoat conforming to 4.1.2.3.3 shall be at a DFT of 75 to 125 micrometers (3 to 5 mils). As an alternate, surfaces may be topcoated with a heat-resistant coating material such as a silicone ablative.

c. Zone 3. An intermediate/tie coat and a finish coat conforming to 4.1.2 shall be applied in accordance with 4.4.3. As an alternate, an inorganic topcoat conforming to 4.1.2.3 shall be applied at a DFT of 75 to 125 micrometers (3 to 5 mils) or a polysiloxane finish coat conforming to 4.1.2.3.4 shall be applied at a DFT of 75 to 125 micrometers (3 to 5 mils).

d. Zones 4a, 4b, and 4c. No topcoats are required, except for color coding, safety, identification, or special conditions. When required, topcoats shall be in accordance with 4.5.1.3.5.c.

e. Zone 5. Metallized zinc coating is suggested but not required. As an alternate, use inhibitive epoxy primer and a polyurethane finish coat conforming to 3.1.2 at the manufacturer's recommended thickness.

f. Zone 6. The coating system shall be as specified in 4.5.4 and 4.5.5.

g. Zone 7. The coating system shall be as specified in NACE Publication No. 6H189.

4.5.2 Protection of aluminum.

NOTE: Aluminum requires special coatings if immersion conditions could occur. See 4.5.4 for coatings for immersion.

4.5.2.1 Surface preparation of aluminum.

CAUTION: Some aluminum configurations are susceptible to distortion and/or destruction when they are abrasive blasted. Special care shall be taken to ensure against any metal damage by choice of abrasive aggregate and by reducing blast nozzle pressure and increasing the working distance from nozzle to surface as necessary. In some cases, such as in the surface preparation of light-gage sheet, these precautions may not be sufficient to prevent distortion, and an alternate procedure, such as abrading or mechanical cleaning, must be used to remove corrosion or roughen the surface. Aluminum surfaces shall be abrasive blasted with fine abrasive conforming to the requirements in 4.1.1 to remove corrosion and old coatings or roughen new surfaces. The blasted surface shall be free of all corrosion and foreign matter and have a uniform, slightly roughened appearance.

Aluminum shall be prepared by degreasing and abrasive blasting or mechanical cleaning, as required by the condition and configuration of the surface. Abrasive blasting shall be used whenever possible using nonmetallic abrasives specified in 4.1.1. Mechanical cleaning shall be used only when abrasive blasting is impractical, would damage the structure or component, or is prohibited in the area of work. Aluminum shall be mechanically cleaned in accordance with SSPC-SP 3 using abrasive discs/sheets, or other approved methods. All corrosion and foreign matter shall be completely removed and the entire surface slightly roughened. Anodized or chemical conversion coated aluminum surfaces shall not be mechanically cleaned.

Abrasive blasting of bellows, gimbal joints, and other thin-walled, abrasion-sensitive components shall be blasted with walnut shells, plastic media, or approved equivalent in accordance with 4.1.1.

4.5.2.2 Protective coatings. The following protective coatings shall be applied to aluminum surfaces as required for each zone of exposure described in 1.1.

a. Zones 1, 2, and 3. The following coatings can be used to protect aluminum in the launch environment. To facilitate washdown of solid rocket booster (SRB) residue on critical hardware, inhibited polymide epoxy coating and aliphatic polyurethane topcoat may be used as well as other coatings such as polysiloxane and inorganic topcoats.

b. Zones 4 and 5. No protective coatings are required except for color coding, safety, identification, or special conditions for normal atmospheric service of 1000, 5000, and 6000 series alloys. However, aluminum that is located within 3.5 kilometers (2 miles) of the coastline, subject to chemical exposure, or other series alloys shall be fully coated according to 4.5.2.2.a.

c. Zone 6. The coating system shall be as specified in 4.5.4 and 4.5.5.

d. Zone 7. The coating system shall be as specified in NACE Publication No. 6H189.

4.5.3 Protection of stainless steel.

NOTE: Thin-walled 300-series stainless-steel tubing is subject to pitting corrosion failure in outdoor marine environments. For exterior installations, this tubing shall be degreased, prepared with a stainless-steel wire wheel or equal, and coated in accordance with 4.5.3.2.

4.5.3.1 Surface preparation of stainless steel. Stainless steel shall be prepared by degreasing in accordance with SSPC-SP 1 and mechanical cleaning or abrasive blasting. Abrasive blasting shall be used whenever possible. Using nonmetallic abrasives specified in 4.1.1, stainless steel shall be mechanically cleaned in accordance with SSPC-SP 3 using abrasive discs/sanding sheets, or other approved methods. All corrosion and foreign matter shall be completely removed and the entire surface slightly roughened.

CAUTION: Some stainless steel configurations are susceptible to distortion and/or destruction when they are abrasive blasted. Special care shall be taken to ensure against any metal damage by choice of abrasive aggregate and by reducing blast nozzle pressure and increasing the working distance from nozzle to surface as necessary. In some cases, such as in the surface preparation of light-gage sheet, these precautions may not be sufficient to prevent distortion, and an alternate procedure, such as abrading or mechanical cleaning, must be used to remove corrosion or roughen the surface. Stainless steel surfaces shall be abrasive blasted with fine abrasive conforming to the requirements in 4.1.1 to remove corrosion and old coatings or roughen new surfaces. The blasted surface shall be free of all corrosion and foreign matter and have a uniform, slightly roughened appearance.

4.5.3.2 Protective coating.

a. Zones 1, 2, and 3. The following coatings can be used to protect stainless steel in the launch environment. To facilitate washdown of SRB residue on critical hardware, inhibited polyamide epoxy coating and aliphatic polyurethane topcoat may be used as well as other coatings such as polysiloxane and inorganic topcoats.

b. Zones 4 and 5. No protective coatings are normally required for normal atmospheric service except for color coding, safety, identification, or special conditions. As an alternative for special conditions, stainless steel may be brush blasted and coated with inhibitive epoxy primer to a DFT of 50 to 75 micrometers (2 to 3 mils) followed by an appropriate finish coat that will provide a DFT of 50 to 75 micrometers (2 to 3 mils).

c. Zone 6. The coating system shall be as specified in 4.5.4 and 4.5.5.

d. Zone 7. The coating system shall be as specified in NACE Publication No. 6H189.

4.5.4 Underground, submerged, or continuously wetted surfaces. Surfaces that will be underground, submerged, or continuously wetted shall be prepared in accordance with SSPC-SP 5 with a profile of 75 to 100 micrometers (3 to 4 mils) and coated with coal tar epoxy conforming to 4.1.2.5.

NOTE: Coal tar epoxy coatings shall not be used for contact with potable water.

The coating shall be applied to a minimum DFT of 410 micrometers (16.0 mils) and checked for missed areas or pinholes with a properly calibrated holiday detector in accordance with NACE RP0188-88. Cathodic protection requirements shall be coordinated with the application of this coating.

4.5.5 Coating systems for potable water immersion service. All surface preparation for carbon steel shall be in accordance with SSPC-SP 5 with a surface profile of 75 to 100 micrometers (3 to 4 mils). All coatings for potable water service shall be selected from 4.1.2.6. All potable water coating systems shall be inspected in accordance with NACE standard recommended practices RP0288-88 and with RP0188-88.

4.5.6 Provision for nonskid surfaces. Where a nonskid walking surface is required, a nonskid coating conforming to 4.1.2.8 shall be applied as follows:

a. Carbon steel. Apply directly over the zinc coating (inorganic zinc or galvanizing). Follow surface preparation instructions defined for topcoating in 4.5.1.

b. Aluminum and stainless steel. Apply directly over these surfaces after surface preparation following instructions defined for topcoating in 4.5.2 and 4.5.3.

4.5.7 Coating systems for metallic surfaces under thermal insulation. Coating systems for carbon steel and stainless steel surfaces under thermal insulation and cementitious fireproofing shall be as specified in NACE Publication No. 6H189.

4.5.8 Repair of applied coatings. Newly applied coatings shall be repaired in accordance with Table I. Surfaces shall be prepared by water washing and by mechanical methods to SSPC-SP 11 to remove corrosion, weld slag, and to "feather back" coating edges. Touchup and repair shall be accomplished promptly after the damage has occurred. Touchup and repair of shop-applied coatings shall be accomplished using coatings from the same manufacturer as those applied in the shop.

4.5.9 Maintenance of existing coatings. Each support contractor responsible for maintaining facilities or ground support equipment shall develop a Coating Maintenance Plan. The plan shall include the following key elements: record keeping, routine inspection of facilities, coating repair criteria, coating systems, equipment requirements, procedures, training and certification, in-process inspection, and worker protection and environmental compliance. All operations shall be in strict accordance with 4.3.3.

5. QUALITY ASSURANCE PROVISIONS

5.1 Responsibility for inspection. The coating contractor/applicator shall provide continuous quality control inspection of his work to ensure complete conformance to the project specifications. A project-specific quality control coating inspection plan shall be submitted to the Contracting Officer for approval.

In addition, the Government and/or the Government's representative shall provide inspection of the surface preparation and coating application processes defined herein as required by the project specifications. The inspector shall perform all of the in-process inspections required by this standard and the project specifications. The assigned inspector shall be certified under

NACE Coating Inspector Program (CIP). The inspector shall witness, inspect, and test all protective coating work to verify complete compliance with the specified requirements. The assigned inspector shall document the work on the inspection forms described in 4.4. The daily inspection reports shall be prepared and signed daily and submitted to the Contracting Officer on a weekly basis as a minimum. When a nonconformance report is required, it shall be signed and submitted to the Contracting Officer within 1 working day from the time that it is written. After determining that all nonconformances have been corrected and/or the coating work is in compliance with this standard and the project specifications, a conformance verification report shall be completed for the specific item, area, or project. This report shall be signed and sealed by the assigned inspector. The application of the certified inspector's seal to the verification conformance report indicates that he has personally inspected the indicated work and has found it to be in compliance with the specified requirements. The seal shall not be affixed to the daily inspection report or to the nonconformance report. The contractor/applicator shall provide the inspector with safe access to the work.

TABLE I. Repair of Applied Coatings

Existing Coating	Repair Coating
Inorganic zinc	
Zones* 1 and 4	Inorganic zinc/epoxy mastic for small area touchup
Zone 2	Inorganic zinc/inorganic topcoat
Zones 3 and 5	Epoxy mastic/polyurethane/polysiloxane system for small area touchup
Galvanized steel	
Zones 1 and 4	Inorganic zinc/epoxy mastic for small area touchup
Zone 2	Inorganic zinc/inorganic topcoat
Zones 3 and 5	Epoxy mastic/polyurethane/polysiloxane system for small area touchup
Inorganic topcoat	
All zones	Inorganic zinc/inorganic topcoat
Epoxy/Polyurethane**	
Zones 3, 4 and 5	Epoxy/polyurethane system/polysiloxane
Water reducible	
Zones 3, 4, and 5	Water reducible intermediate/finish
Coal tar epoxy	
Zone 6	Coal tar epoxy

* Zones are defined in 1.1

**When this coating is replaced with inorganic zinc, complete removal of the existing coating is required.

The CIP is provided by NACE International, Education Department, P.O. Box 218340, Houston, Texas, 77218-8340, (281) 228-6200, FAX (281) 228-6300.

5.2 Requirements for inspection.

a. Zones 1, 2, and 3. Since these zones are located in the highly corrosive launch environment or other chemical exposures, NACE inspection shall be required for all surface preparation and coating applications. This includes all new work, new work touchup, major refurbishment of existing coatings, and modifications.

b. Zone 4. For systems requiring abrasive blasting and coating of metallic substrates, all surfaces shall require full NACE inspection with the following exception: For touchup of existing coatings, NACE inspection is not mandatory but recommended in cases of critical systems or equipment.

c. Zone 5. All clean-room structures fabricated of aluminum or carbon steel that will be abrasive blast cleaned and/or coated outside Zone 5 environments require NACE inspection. All other aluminum or carbon steel structures in Zone 5 environments are exempt from NACE inspection.

d. Zone 6. Since this zone is located in a highly corrosive underground environment or other submerged exposures, NACE inspection shall be required for all surface preparation and coating applications. This includes all new work, new work touchup, major refurbishment of existing coatings, and modifications.

e. Zone 7. Since this zone is located in a highly corrosive environment, NACE inspection shall be required for all surface preparation and coating applications. This includes all new work, new work touchup, major refurbishment of existing coatings, and modifications.

5.3 Inspection hold points. Mandatory inspection hold points shall include but not be limited to the following:

a. Verification of ambient weather conditions in accordance with 4.4.3.5

b. Prior to beginning of surface preparation work, to include the operation of equipment

c. After surface preparation work and before the beginning of the coating application work, to include the mixing of products

a. Before and after the application of each coat of material

e. After completion and prior to final acceptance

5.4 Inspection forms. All inspections shall be recorded and documented on forms acceptable to the customer. See Appendix E for examples of forms to be used.

5.5 Inspection prior to surface preparation and coating application. The following conditions shall be inspected prior to commencement of surface preparation and coating application operations.

5.5.1 Surface condition. The surface condition shall be visually inspected for compliance with 4.4.2. Special attention shall be given to weld spatter, sharp edges, flame or saw cuts, delaminations, burrs, slag, or other surface irregularities that effect performance of protective coatings prior to surface preparation.

5.5.2 Protection of adjacent surfaces. Adjacent surfaces shall be visually inspected for adequate protection in accordance with 4.4.2. This inspection shall be in conjunction with Government Quality Engineering.

5.5.3 Ambient weather conditions. The ambient weather conditions at the actual location of the work shall be determined before and during the surface preparation and coating application operations to ensure they are correct for the work being conducted. The air temperature, relative humidity, and dewpoint shall be determined through the use of a psychrometer in accordance with the manufacturer's instructions. The surface temperature shall be determined by using a surface temperature thermometer. Wind speed and direction shall be determined with a suitable instrument. No spray painting may proceed when the measured wind speed in the immediate coating area is above 25 kilometers per hour (15 miles per hour). All of these ambient weather conditions shall be recorded on the Coating System Daily Inspection Report as shown in Appendix E.

5.5.4 Compressed air cleanliness. The compressed air supply shall be inspected for the use of inline moisture and oil traps. Proper functioning of the traps shall be evaluated daily by allowing the air supply (down line from the traps) to blow against a clean, white cloth for several minutes. No moisture or oil should be deposited on the cloth.

5.5.5 Surface salt concentration. On structures within 3.5 kilometers (2 miles) of the ocean shore, the surface chloride concentration shall be determined using Saltesmo test strips (available from Gallard-Schlesinger Chemical Manufacturing Corporation [516] 333-5600) or other suitable methods and recorded in the inspection records weekly. Surfaces that measure 50 milligrams per square meter (0.00016 ounce per square foot) or above require water washing in accordance with 4.4.2.1.

5.6 Surface preparation inspection. The following inspections shall be made to ensure compliance with the surface preparation requirements in 4.4.2.

5.6.1 Abrasive blasting material. The abrasive blasting material shall be verified for compliance with 4.1.1.

5.6.2 Blast nozzle air pressure and size. The air pressure at the blast nozzle shall be determined through the use of a hypodermic needle air pressure gage. The needle of the gage shall be inserted as close to the nozzle as practically possible and in the direction of the air flow. Pressure readings should be taken with the blasting system in complete operation. The nozzle pressure shall be recorded. The nozzle shall be checked initially and then at a frequency determined by the NACE inspector with a blast nozzle orifice gage to ensure the compressor output correlates with the nozzle size.

5.6.3 Degree of surface cleanliness. The surface cleanliness shall be inspected after the completion of surface preparation procedures and prior to primer application to determine compliance with the applicable requirements of 4.5. The degree of cleanliness of abrasive blasted carbon steel shall be verified through the use of visual standards in accordance with 4.5.1.1.2. Galvanized steel, aluminum, and stainless steel shall be inspected for cleanliness in

accordance with 4.5.1.2, 4.5.2, and 4.5.3. The surface preparation cleanliness requirements defined in 4.5 shall be applicable to 100 percent of the subject area, including places that are difficult to reach. Use of SSPC-VIS 1-89 and SSPC-VIS 3-95 is recommended for judging surface cleanliness.

5.6.4 Surface profile or roughness. The anchor profile of an abrasive-blasted carbon steel surface shall be determined by using a surface profile gage, comparator, or replica tape. The profile shall be in accordance with 4.5.1.1.2. Galvanized steel, stainless steel, and aluminum surfaces shall be visually inspected as required for slight roughening in accordance with 4.5.1.2, 4.5.2, and 4.5.3.

5.6.5 Blasting of abrasive-sensitive components. Thin-walled, abrasive-sensitive components such as bellows assemblies or tubing will be protected during normal blasting operations in accordance with 5.5.2. Surface preparation of these sensitive components will use walnut shell or approved equivalent in accordance with 4.1.1 or mechanical methods in accordance with 4.4.2.3.

5.7 Coating application inspection. The following inspections shall be made to ensure compliance with the coating application requirements defined in 4.4.3.

5.7.1 Surface condition. The prepared surface shall be visually inspected and the time before coating shall be monitored for compliance with 4.4.3 before coatings are applied.

5.7.2 Coating materials. The coating materials shall be visually inspected for compliance with 4.4.3.1.

5.7.3 Storage of coating material. Coating material storage conditions shall be periodically inspected for compliance with 4.4.3.3.

5.7.4 Mixing and application of coatings. The mixing and application of all coatings shall be visually inspected to ensure compliance with 4.4.3.4, 4.4.3.6, and 4.4.3.9.

5.7.5 Coating finish and DFT. The finish and DFT of each applied coating shall be inspected for compliance with 4.4.3.7 and 4.5 prior to the application of successive coats. The DFT measurement on carbon steel shall be taken using a magnetic gage calibrated in accordance with SSPC-PA 2. DFT measurements taken in accordance with SSPC-PA 2 shall not have any readings below minimum specified while considering the accuracy of the measurement instrument. DFT measurements on aluminum and stainless steel shall be taken using an eddy current instrument that has been properly calibrated on surfaces similar to the coated surface.

5.8 Caulking inspection. All surfaces shall be visually inspected to determine compliance with the requirements for sealing and caulking in accordance with 4.4.4.

5.9 Galvanizing inspection. Galvanized carbon steel shall be inspected in accordance with the applicable ASTM standard in 4.5.1.2.1.

6. PREPARATION FOR DELIVERY

Not applicable.

7. NOTES

(This section contains information of a general or explanatory nature which may be helpful but is not mandatory.)

7.1 Intended use. This standard is intended to establish uniform practices, methods, and procedures. The information provided herein shall be used for the preparation of written, individual coating specifications for specific projects for the prevention of corrosion through the use of protective coatings on space vehicle launch structures, facilities, ground support equipment, and test facilities and structures in all environments. Due to the changing environmental considerations, new advances in corrosion control technology, and the wide array of possible applications, this document shall not be used as a stand-alone specification that meets every contingency. Attached Appendices are considered to be an integral part of this standard and should be used in the preparation of all coating specification and coating operations.

7.2 Additional related information. For information and guidance on dissimilar metals, corrosion-inhibiting lubricants, etc., refer to T.O. 1-1-691 and KSC-TM-584.

7.3 Key word listing.

facilities
ground support equipment
protective coating
structures

APPENDIX A

APPROVED PRODUCTS LIST FOR INORGANIC ZINC COATINGS

This list has been prepared for use by or for the Government in the procurement of products covered by this document, and such listing of a product is not intended to and does not connote endorsement of the product by NASA. All products listed herein have been tested and meet the requirements for the product as specified. This list is subject to change without notice; revisions or amendments of this list will be issued as necessary. The listing of a product does not release the supplier from compliance with the specification requirements. This list is arranged in two sections based on the coating material's Volatile Organic Content (VOC). Use of the information shown hereon for advertising or publicity purposes is strictly forbidden.

Thinners and cleaners for each of these coatings shall be procured from the manufacturer of the coating in accordance with 4.4.3.1 and 4.4.3.4.

The agency responsible for this list is the KSC Spaceport Technology Development Office (YA-C2).

Section I. Materials With Greater Than 420 Grams/Liter (3.5 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Coating Designation	Type	Manufacturer
Dimetcote 9	SB	Ameron International, P.C.F.G. 201 North Berry Street Brea, CA 92821 (800) 926-3766 www.ameron.com
MZ 13-F-12	SB	
Carbo-Zinc 11	SB	Carboline Company 350 Hanley Industrial Court St. Louis, MO 63114 (800) 677-0753 www.carboline.com
Cathacoat 304	SB	ICI Devoe Coatings 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
Ganicin 347-Y-931	SB	DuPont Co. P. O. Box 80021 Wilmington, DE 19880 (302) 992-4928 (800) 572-1568

Coating Designation	Type	Manufacturer
PPG 1001	SB	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppg.com
Zinc-Clad B69-V-1	SB	Sherwin-Williams Company 101 Prospect Avenue N.W. Cleveland, OH 44115 (800) 336-1110 www.sherwin-williams.com
Sigma 7551	SB	Sigma Coatings, USA P.O. Box 816 Harvey, LA 70059 (504) 347-4321 (800)221-7978 www.sigmacoatings.com

Section II. Materials With Less Than 340 Grams/Liter (2.8 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Coating Designation	Type	Manufacturer
Dimetcote D-21-9 Dimetcote D-9HS	SB SB	Ameron P.C.F.G. 210 North Berry Street Brea, CA 92821 (800) 926-3766 www.ameron.com
Carbo-Zinc 11HS Carbo-Zinc D7 Carbo-Zinc 11 VOC	SB WB SB	Carboline Company 350 Hanley Industrial Court St. Louis, MO 63114 (800) 677-0753 www.carboline.com
Cathacoat 305 Cathacoat 304V Cathacoat 304H	WB SB SB	ICI Devoe Coatings Co. 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
Ganicin 347WB	WB	DuPont Co. 1007 Market Street Wilmington, DE 19898 (302) 992-4928 (800) 572-1568

Coating Designation	Type	Manufacturer
Galvosil 1562	WB	Hempel Coatings, Inc. 6901 Cavalcade Houston, TX 77028 (713) 672-6641 www.hempel.com
InterZinc 22HS	SB	International Paint 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 www.international-pc.com
Zinc Clad II Zinc Clad IIHS	SB SB	Sherwin-Williams Company 101 Prospect Avenue N.W. Cleveland, OH 44115 (800) 336-1110 www.sherwin-williams.com
Tornusil 7550 Sigma 7551 US	WB SB	Sigma Coatings, USA P.O. Box 826 Harvey, LA 70059 (504) 347-4321 (800) 221-7978 www.sigmacoatings.com

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APPENDIX B

APPROVED PRODUCTS LIST FOR TOPCOAT SYSTEMS

This list has been prepared for use by or for the Government in the procurement of products covered by this document, and such listing of a product is not intended to and does not connote endorsement of the product by NASA. All products listed herein have been tested and meet the requirements for the product as specified. This list is subject to change without notice; revisions or amendments of this list will be issued as necessary. The listing of a product does not release the supplier from compliance with the specification requirements. This list is arranged in two sections based on the coating material's Volatile Organic Content (VOC). Use of the information shown hereon for advertising or publicity purposes is strictly forbidden.

Thinners and cleaners for each of these coatings shall be procured from the manufacturer of the coating in accordance with 4.4.3.1 and 4.4.3.4.

The agency responsible for this list is the KSC Spaceport Technology Development Office (YA-C2).

Section I. Materials With Greater Than 420 Grams/Liter (3.5 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Primer (Type)	Midcoat (Type)	Topcoat (Type)	Manufacturer
Cathacoat 304 (SB)	201 (SB)*	359 (SB)	ICI Devoe Coatings Co. 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
Cathacoat 304 (SB)	230 (SB)	369 (SB)	
Cathacoat 304 (SB)	201 (SB)*	369 (SB)	
PPG 1001 (SB)	97-139 (SB)	97-812 (SB)	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppg.com
PPG 1001 (SB)	97-148 (SB)	97-812 (SB)	
Sigma 7551 (SB)	5434 (SB)	5523 (SB)	Sigma Coatings, USA P.O. Box 826 Harvey, LA 70059 (504) 347-4321 (800) 221-7978 www.sigmacoatings.com

*Can be used as a direct to metal primer for stainless steel, aluminum, and Zone 5 environments.

Section II. Materials With Less Than 340 Grams/Liter (2.8 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Primer (Type)	Midcoat (Type)	Topcoat (Type)	Manufacturer
D-21-9 (SB) D-21-9 (SB) D-9 NS (SB)	400 (SB)*	450HS (SB) PSX700 (SB) PSX700 (SB)	Ameron P.C.F.G. 210 North Berry St. Brea, CA 92821 (800) 926-3766 www.ameron.intl.com
CZ-11HS (SB) CZ-11HS (SB) CZ-D7 (WB)	893 (SB) CM-15 (SB)* 3358 (WB)	134HS (SB) 3359 (WB) 3359 (WB)	Carboline Company 350 Hanley Industrial Ct. St. Louis, MO 63114 (800) 677-0753 www.carboline.com
Cathacoat 304 V (SB)	201 H (SB)	379 (SB)	ICI Devoe Coatings Co. 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
Ganicin 347 (WB)	25P (SB)	333 (SB)	DuPont Co. 1007 Market Street Wilmington, DE 19898 (302) 992-4928 (800) 572-1568

*Can be used as a direct to metal primer for stainless steel, aluminum, and Zone 5 environments.

Section III. Inorganic Topcoat Systems (SB is Solvent-Based and WB is Water-Based):

Primer (Type)	Midcoat (Type)	Topcoat (Type)	Manufacturer
D-21-9 (SB) D-9 HS (SB)		741 (SB) (IOT)	Ameron P.C.F.G. 210 North Berry St. Brea, CA 92821 (800) 926-3766 www.ameron.intl.com
CZ-11 VOC (SB)		L3910-50 (SB) (IOT)	Carboline Company 350 Hanley Industrial Court St. Louis, MO 63114 (800) 677-0753 www.carboline.com

Primer (Type)	Midcoat (Type)	Topcoat (Type)	Manufacturer
Cathacoat 304V (SB)		701 (SB) (IOT)	ICI Devoe Coatings Co. 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
InterZinc 22HS (SB)		181 (SB) (IOT)	International Paint 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 www.international-pc.com
Zinc Clad II (SB) Zinc Clad II HS (SB)		LO3 (SB) (IOT)	Sherwin-Williams Company 101 Prospect Avenue N.W. Cleveland, OH 44115 (800) 336-1110 www.sherwin-williams.com
Sigma 7551 US (SB)		5555 (SB) (IOT)	Sigma Coatings, USA P.O. Box 826 Harvey, LA 70059 (504) 347-4321 (800) 221-7978 www.sigmacoatings.com

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APPENDIX C

APPROVED PRODUCTS LIST FOR CHIP-FREE CLEAN ROOM PAINT

Primer	Intermediate	Topcoat	Manufacturer
Intershield PRA 150/151	Intershield PGA 750/75	Intershield (white)PRA 550/560 Interthane (other color)	International Paint Courtaulds Coatings 3489 N.W. 167th St. Miami, FL 33056 (305) 620-9220 www.international-pc.com
Chemglaze 9720	Aeroglaze M1433	Aeroglaze A276	Lord Corporation Chemical Products Division P.O. Box 10038 Erie, PA 16514 (814) 868-3611
Chemglaze 9720	Aeroglaze M1433	Aeroglaze K3202	
Chemglaze 9720	Aeroglaze M1433	Chemglaze P250*	

*This system should not be used in areas where static discharge may be a problem.

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APPENDIX D

COATING SPECIFICATION KEY ELEMENTS

1. SCOPE
2. APPLICABLE DOCUMENTS
3. SUBMITTALS
4. ENVIRONMENTAL PROTECTION
5. WASTE MANAGEMENT
6. SAFETY/PERSONNEL PROTECTION
7. MATERIALS
8. TOOLS AND EQUIPMENT
9. ENVIRONMENTAL CONDITIONS
10. WORK SCHEDULE
11. SURFACE PREPARATION
12. COATING SCHEDULE (see next page)
13. COATING MIXING AND APPLICATION
14. QUALITY CONTROL INSPECTION
15. REPORTING
16. FINAL ACCEPTANCE

APPENDIX D

COATING SCHEDULE

SURFACE DESCRIPTION (STEEL, CONCRETE, SURFACE A, B, ETC.)	APPROXIMATE SURFACE AREA SQUARE FEET	SURFACE PREPARATION TYPE	PROFILE RANGE	FIRST COAT			SECOND COAT			THIRD COAT		
				TYPE	WFT/ DFT	COLOR	TYPE	WFT/ DFT	COLOR	TYPE	WFT/ DFT	COLOR

APPENDIX E

COATING SYSTEM DAILY INSPECTION REPORT

COATING SYSTEM DAILY INSPECTION REPORT

DATE	REPORT NO.	PROJECT REF. NO.	PAGE OF
PROJECT DESCRIPTION	LOCATION	CONTRACTOR	
INSPECTING ORGANIZATION	INSPECTOR	APPLICABLE SPECIFICATION NO.	

I. DESCRIPTION OF ITEMS AND/OR AREAS

II .DESCRIPTION OF WORK PERFORMED/REMARKS

SAMPLE

III. PRE-WORK SURFACE CONDITION

- ☐ SUBSTRATE _____
- ☐ GENERAL DESCRIPTION _____
- ☐ PRIMED FOR SUBSEQUENT COATS: REFERENCE REPORT DATED _____
- ☐ PREVIOUSLY PAINTED. DEGREE OF CORROSION _____
- ☐ NEW METAL. DEGREE OF CORROSION _____

OBSERVED DEFECTS

		CORRECTED
OIL & GREASE	☐	☐
SHARP EDGES	☐	☐
WELD SPATTER	☐	☐
MOISTURE	☐	☐
LAMINATIONS	☐	☐
SOLUBLE SALTS	☐	☐
_____	☐	☐
_____	☐	☐

IV. ENVIRONMENTAL CONDITIONS

TIME	:	:	:	:
AIR TEMP °F				
WET BULB TEMP °F				
RELATIVE HUMIDITY	%	%	%	%
DEW POINT °F				
SURFACE TEMP MIN/MAX °F	/	/	/	/
WIND DIRECTION				
WIND SPEED (MPH)				

REMARKS

V. SURFACE PREPARATION

- ☐ SOLVENT CLEAN _____
- ☐ HAND TOOL _____
- ☐ POWER TOOL _____
- ☐ HP WATER WASH _____
- ☐ _____
- ☐ _____

☐ **ABRASIVE BLAST**

- ABRASIVE TYPE _____
- BLAST NOZZLE PRESSURE _____
- SURFACE PROFILE (AVG) _____
- DEGREE OF SURFACE CLEANLINESS _____
- COMPRESSED AIR CLEANLINESS _____

START TIME ____:____ STOP TIME ____:____
APPROXIMATE SQ. FT. PREPARED _____
REMARKS _____
PROFILE EFFECT ON TYPE ☐ 1 ☐ 2 GAUGE _____mils

VI. PRODUCT/MIXING

COATING PRODUCT TYPE	MANUFACTURER	CATALOG NO./NAME	COLOR

COATING BATCH NUMBERS
(A) _____
(B) _____
(C) _____

THINNING
THINNER _____
BATCH NO. _____
QTY ADDED _____
% BY VOLUME _____

CAULKING
TYPE _____
MFG _____
PRODUCT NO. _____
BATCH NO. _____

☐ **FIRST COAT**
☐ **SECOND COAT**
☐ **THIRD COAT**
☐ _____

TIME MIXED _____ : _____
KIT SIZE _____
GALS MIXED _____
CONTAINER CONDITION _____
PROPERLY STORED? _____
MIXING INSTRUMENT _____
MATERIAL TEMP °F _____

REMARKS _____

VII. COATING APPLICATION

METHOD OF APPLICATION _____
EQUIPMENT DESCRIPTION _____
ATOMIZING AIR CLEANLINESS _____
BRUSHED STRIPE COAT APPLIED TO HARD TO COAT AREAS? _____

START TIME ____:____ STOP TIME ____:____
APPROXIMATE SQ. FT. COATED _____
GALS COATING APPLIED _____
REMARKS _____
WET FILM THICKNESS (AVG) _____ MILS

VIII. POST CURE INSPECTION

☐ DFT WORKSHEET ATTACHED

	GAUGE READING	ACTUAL	DATE VERIFIED
SURFACE EFFECT ON GAUGE		N/A	
TOTAL DFT FROM PREVIOUS COATS (AVG)			
DFT THIS COAT (AVG)			

GENERAL APPEARANCE/REMARKS _____

IX.NON-CONFORMANCE ITEMS

DESCRIPTION OF DEFECT	DEFECTIVE ITEMS/AREAS	SPECIFICATION REF. SECTION	N.C.R. NO.	DATE CORRECTED

_____
INSPECTOR'S SIGNATURE DATE

KSC FORM 28-589 (REV. 8/95)

APPENDIX E (CONT'D)

COATING SYSTEM DAILY INSPECTION REPORT

COATING SYSTEM DAILY INSPECTION REPORT (CONTINUATION SHEET)

DATE	REPORT NO.	PROJECT REF. NO.	PAGE OF

TIME	REMARKS

INSPECTOR'S SIGNATURE DATE

KSC FORM 28-589A (3/91)

APPENDIX F

DRY FILM THICKNESS MEASUREMENT WORKSHEET

DRY FILM THICKNESS MEASUREMENT WORKSHEET

DATE	REPORT NO.	PROJECT REF. NO.	APPLICABLE SPECIFICATION	PAGE OF

ITEM/AREA DESCRIPTION	SPOT	SPOT READINGS 1	2	3	TOTAL	AVG (÷3)	% MIN
	A						
	B						
	C						
APPROX SQ. FT.	D						
	E						

SPECIFIED DFT ____ - ____ MILS | TOTAL
RANGE ACHIEVED ____ - ____ MILS | AVG (÷5)
REFERENCE REPORT DATED ________ FOR APPLICATION RECORD

ITEM/AREA DESCRIPTION	SPOT	SPOT READINGS 1	2	3	TOTAL	AVG (÷3)	% MIN
	A						
	B						
	C						
APPROX SQ. FT.	D						
	E						

SPECIFIED DFT ____ - ____ MILS | TOTAL
RANGE ACHIEVED ____ - ____ MILS | AVG (÷5)
REFERENCE REPORT DATED ________ FOR APPLICATION RECORD

ITEM/AREA DESCRIPTION	SPOT	SPOT READINGS 1	2	3	TOTAL	AVG (÷3)	% MIN
	A						
	B						
	C						
APPROX SQ. FT.	D						
	E						

SAMPLE

SPECIFIED DFT ____ - ____ MILS | TOTAL
RANGE ACHIEVED ____ - ____ MILS | AVG (÷5)
REFERENCE REPORT DATED ________ FOR APPLICATION RECORD

ITEM/AREA DESCRIPTION	SPOT	SPOT READINGS 1	2	3	TOTAL	AVG (÷3)	% MIN
	A						
	B						
	C						
APPROX SQ. FT.	D						
	E						

SPECIFIED DFT ____ - ____ MILS | TOTAL
RANGE ACHIEVED ____ - ____ MILS | AVG (÷5)
REFERENCE REPORT DATED ________ FOR APPLICATION RECORD

ITEM/AREA DESCRIPTION	SPOT	SPOT READINGS 1	2	3	TOTAL	AVG (÷3)	% MIN
	A						
	B						
	C						
APPROX SQ. FT.	D						
	E						

SPECIFIED DFT ____ - ____ MILS | TOTAL
RANGE ACHIEVED ____ - ____ MILS | AVG (÷5)
REFERENCE REPORT DATED ________ FOR APPLICATION RECORD

ITEM/AREA DESCRIPTION	SPOT	SPOT READINGS 1	2	3	TOTAL	AVG (÷3)	% MIN
	A						
	B						
	C						
APPROX SQ. FT.	D						
	E						

SPECIFIED DFT ____ - ____ MILS | TOTAL
RANGE ACHIEVED ____ - ____ MILS | AVG (÷5)
REFERENCE REPORT DATED ________ FOR APPLICATION RECORD

REMARKS

TOTAL SQUARE FOOTAGE COATED (APPROX)	INSPECTOR'S SIGNATURE	DATE

KSC FORM 28-588 (3/91)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers ***or clarification of*** requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER **NASA-STD-5008A**	2. DOCUMENT DATE **January 21, 2004**

3. DOCUMENT TITLE

Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)*	7. DATE SUBMITTED

8. PREPARING ACTIVITY

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